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Growing Cinchona under American Control*

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In talking with Dr. Bonisteel, your former editor of Torreya, I asked him what he thought I should stress before the Club and he replied, "Go after the dependence of our country on tropical economic plants for the sinews of our industry."

Cinchona is, of course, an outstanding example. In World War I, we were dependent on the Dutch, and Mr. Herbert Hoover, then food administrator, cabled to the Philippines to raise quinine. The Forestry Bureau had a few trees of *C. succirubra* of rather low alkaloid content growing, and efforts were made to obtain seed from Java and India. The seed from India was good seed, but not of the high yielding variety, *Ledgeriana,* and the seed from Java did not grow. However, we did learn a little about the idiosyncrasies of the genus and when General Leonard Wood was appointed Governor General, he made funds available to purchase seed from Java which were obtained for us by Consul General Hoover in Batavia, and from this seed a definite start was made in the plantation industry.

It may be of interest to you to hear how we proceeded. The first criterion laid down was that we had to bring costs down to a competitive level with Java with much higher labor costs in the Philippines. We had therefore to devise and develop field methods which reduced labor to a minimum and increased alkaloid content to a maximum. Terracing was too costly except for nursery beds, and therefore out in plantations. Drainage and soil, and particularly aeration of soil, became the primary basis for the plantation site selections in regions of sufficient rainfall and elevation. Plantings were therefore made on contours.

Forests with good forest soil and thick humus were desired for plantations. They were opened up sufficiently around planting holes to admit one-fourth to one-third light, and as the plants took hold and grew, brushing out every month or two took place admitting more light gradually. Then, in order not to injure quinine trees, felling of timber was not practiced, but girdling and letting trees die standing until a cover was developed by the quinine. We learned this from sad experience of a three-month drought. The practice also prevented erosion from taking place during the rains in the early stages. Whenever we found forest cover inadequate or insufficient, we used *Crotalaria* spp., *Teph-*

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rosia caudida, Calopogonium and *Centrosema,* not only to hold soil and prevent erosion but we used it as green manure as well. In Java, the practice is to terrace, and every meter or two dig a sump hole on the back end of the terrace about three to four feet long, two feet wide and three feet deep, for aeration and to catch the eroded soil and water, then dig these holes out when filled and pile the soil on the terrace behind. This is good practice where labor is plentiful and cheap.

We then began to check on the alkaloid content of the bark, beginning with two-year old transplants, and set an average content for the area planted, and all plants which by occular survey looked weak or diseased we eliminated, and with this eliminated material the chemists of the Bureau of Science experimented with various methods of extraction. If trees of high alkaloid content were spotted, they were used for bud and seed stock and new areas were planted when seed was produced, and the same procedure of elimination and testing gone through until we had an average alkaloid yield of 9.6% throughout the commercial plantation which today averages better than 10% and some running 14 to 16%.

The trees were pulled as soon as they showed evidence of disease or weakness from two years upward and the average age of final pulling was around six years. Two men could pull a tree by its roots when four to five years old and the bark collected from the roots and stems. Root bark ran higher in content than trunk and stem bark. This method of eliminating by pulling and testing was found the most economical method we could devise. Our goal was the maximum of alkaloid content for the minimum of cost. Some good yielding trees were barked and left growing for bark renewals and seed production, but we found that considerable cross-breeding took place and the seed did not run true to type, so to insure pure type seed we isolated areas with virgin timber as separators.

We noticed that whenever we found early flowering it was an indication that the trees were not growing in their proper environment and that disease, especially cankers, became prevalent. At Impalutao in Bukidnon, at an elevation of 3,800 feet and with a definite dry season, trees flowered at 2½ years, while at Kaatoan, elevation 4,500 feet and no definite dry season, the trees of the same stock flowered at about five years, and disease incidence was greatly reduced and the alkaloid content increased. *Cinchona* flowers about April, May or early June after the dry spells. Flower buds open in 40 to 50 days and mature in 25 to 35 days thereafter. The average height growth per year at Kaatoan was 1.12 meters, the best 1.42 meters.

Our first quantity production of bark took place in about 1927 and some of it sold to European manufacturers. Our analyses in the Bureau of Science at Manila ran between 8.5 and 9.6%, but the Kina Bureau in Holland, which does all the analyses for manufacturers, gave only 7.6%. There was some loss in shipment and we then began to perfect methods of harvesting and drying, and found that an appreciable saving was made in alkaloid content in quick and proper drying and storage. This is a field where still much can be done. If some method can be worked out for either cheap, quick drying at the point of harvesting, or immediate partial extraction with some portable field grinders and extractors, considerable loss in alkaloid content may be overcome. The average dried bark production at six years of age was .5035 kilos per tree and the harvest was around 3,000 trees per hectare, although 6,000 were planted per hectare.

With the quinine surveys taking place in various regions in Central and South America quite a few new species or varieties will be discovered. The nomenclature today is still nebulous to an average forester, and a good monograph on *Cinchona,* straightening out of the species and varieties, would be most welcome. This monograph should include the alkaloid contents of the bark, because species and varieties vary greatly in their total alkaloid content as well as in the proportion of their main alkaloids—Quinine, Cinchonine, Cinchonidine and Quinidine; and the relation of the individual percentages of these alkaloids is indicative of species and varieties.

A great deal of field work is necessary in the study of the species and hybrids of *Cinchona,* and a detailed study of herbarium material is also essential. Some effort along this line is taking place in the various survey parties spotting *Cinchona* in South America, particularly in Ecuador by Dr. Steyermark.

I have been informed that species have been found at 300 to 400 feet elevation in Colombia and Ecuador, and others as high as 10,500 feet in Ecuador and Bolivia. There is no doubt that some of these species can stand some degrees of frost, drying winds and drought, and grow in a variety of soil conditions. When these factors become known, it will then be quite within the range of possibility to develop by cross-breeding a variety which can grow in acid soils along our Gulf Coast under our own flag, with an alkaloid content of four to five per cent.

Another possibility is to breed for specific alkaloid content. This may develop as a result of research by the medical profession on the use of these specific alkaloids. Today, the Office of Experiment stations, U. S. Department of Agriculture, is carrying on work on cross-breeding in Puerto Rico and Hawaii, and all support possible should be given by the public for this work.

The Division of Plant Introduction and Exploration deserves great credit for the work they have done in handling the Philippine Ledgeriana seed and the hybrids. They have developed techniques completely eliminating damping off, developed controls of light, temperature and moisture, and developed methods of packing and shipping seeds and seedlings. It may also be of interest that the percentage of germination of the Ledgeriana seed I brought from the Philippines was around 96% and after two years of seed storage by the Dutch method it now runs around 90%. From published reports, Dr. Morrison's office has grown to date 225,000 seedlings which were shipped to the American tropics as follows: Costa Rica 90,000; Peru 50,000; Ecuador 50,000; Mexico 14,000; Brazil 8,500; Salvador 5,000; Puerto Rico 5,000; Nicaragua 2,000; Colombia 1,000.

The results of the development of quinine in the Philippines have led to the development of virgin areas through lumbering, mining and agriculture, by keeping the incidence of malaria down, and have made labor available for jungle work. We were able to produce totaquina at 14 cents per 250-grain treatment, and made a minimum of ten days additional labor per man per year available at an infinitesimal cost in malarial districts. This also led to a greater interest in the development of drug plants as well as useful jungle produce. South and Centra America have hardly been tapped for useful plants for the sinews of our industry.

We have a large field in the development and production of repellents, such as derris and pyrethrum which now appear to be equal in category with quinine in malaria control. The botanist has a wide virgin field in the American tropics in gathering information and knowledge; and the application of this knowledge to the development of plantation crops, to make this hemisphere as self-sufficient as possible, is a challenge which must be met.

Our greatest failing as Americans, as I said at Rutgers University, is "Let George do it." As long as ease of procurement through brokers or import firms has been prevalent our individual manufacturers and industries have not bothered themselves very much with lack of supply, and this is one of the reasons for the rise of syndicates and cartels in primary products. With much waste arid land in the south and west idle, why haven't we developed a tannin and firewood industry with Australian Black Whattle? We are now dependent on foreign sources for our vegetable tannins, our rubbers, guttas, gums, oils, resins, fibres, and medicinal plants, listing just a few of the plants furnishing the sources of many industries. Looking into the future, I predict that a great portion of our edible oils, starches, fibres, tannins and cellulose will be produced in plantation industries in the tropics where a long growing season prevails. Why not prepare for it now?

Another point which deserves consideration is the apparent reluctance of our country to invest government funds in lands or developments in foreign nations. This policy prevents the United States from owning plantations where continued experimentation and research work can be carried on for our own good, as well as for the good of the country where such work is being conducted. Could not some formula be developed whereby non-profit institutions such as universities and foundations could acquire tropical lands either permanently or for extended periods? This proposition might also apply to professional associations, either in combination, or acting as separate entities. This would encourage a continuity of research, and would permit commercial application of findings under a continuing policy in conjunction with similar institutions in countries best suited for some particular research, study, and development. A reorientation of thinking and of concept is bound to grow out of this war. Agricultural scientists will be called upon to play an all-important role in the future for the joint benefit of our neighbors and ourselves in this Western Hemisphere.

WASHINGTON, D. C.